Source	Text of comment [verbatim but may be split into separate rows for response]	Response	Label(s)
Angstadt	Manure Treatment Technology – Requests 1. Is the manure application process (with bmps) more clearly diagramed in 6.0 beta SB documentation - Figure 3. Manure Application Processes (4.1 ESTIMATING MANURE AVAILABLE IN A COUNTY) than in MTT webinar - Figure B.2 – Conceptual diagram of manure nutrients in the Phase 5.3.2 Watershed Model (slide 10)?	Figure B.2 is consistent with Figure 3 from the Phase 6 Scenario Builder documentation. Figure B.2 will be modified to clarify where the panel's NVE, NSE and PSE values fit in.	Section 2
Angstadt	2. SB 6.0 beta documentation – Table 10 – Dairy manure ammonia = 17.5% of TN. Should MTT efficiency be calculated against total N or only ammonia percentage of TN?	Efficiency is calculated based on total nitrogen and phosphorus in all recommendations.	Modeling
Angstadt	3. Could the EOF load reduction from MTT bmp versus manure application be delineation? · MTT webinar (slide 71) - Example • MTT6: 1 ton Dairy = 84 lbs TN @ 95% = 4 lbs TN · SB with bmps (SB documentation) without MTT – o Table 14: Barnyard ammonia volatilization = 0.65 o Table 17: In-field ammonia volatilization = 0.65 o Table 11: Mineralization fraction = 35% · Could MTT increase available application N?	Load reductions after manure leaves the manure treatment technology is not the task of this panel. We have made a first attempt to determine mass of nutrient transferred to various streams by treatment technologies and provided literature on transformations of nutrients by the technology. Other panels or partnership groups may interpret the downstream consequences of these transformations.	Modeling
Angstadt	4. There is no disputing that volatilizing ammonia N reduces N for manure applications, but ammonia deposition is greatly increased. USDA ARS, Peter Kleinman, has research (MD) that the majority of the ammonia volatilization from poultry production areas returns nearby as dry deposition. Is promoting increased ammonia emissions good environmental policy?	The panel is not advocating increasing ammonia emissions. We have provided recommendations on the total mass of nitrogen transferred from the main manure flow stream to the atmosphere. The nitrogen volatilization efficiencies recommended by this panel may serve as a starting point for future discussions on atmospheric emissions of manure handling systems.	Air
Angstadt	5. How will the 6.0 Airshed Model be adjusted for each MTT bmp reported? Thanks, Bill Angstadt Angstadt Consulting, Inc. P.O. Box 377 Reading, PA 19607 610-334-3390 angstadtconsult@aol.com	Adjustments to the Airshed Model are the purview of the Modeling Workgroup. The CBPO modeling team is already working on some analysis of reactive nitrogen deposition and plan to bring this for discussion at the Modeling Workgroup's August Quarterly meeting. The values in Table ES.1 in the Executive Summary and Table A.2 in Appendix A will be revised to reflect a future decision from the Modeling Workgroup on how	Air-modeling

		to simulate and account for the emissions and redeposition of reactive nitrogen from BMPs within the watershed, including but not limited to the BMPs recommended by this panel.	
USDA ARS	Jeremy - my question (or request) to the MTT is to have the Panel see if they could break down the NVE into what would be likely proportion as N2 (a virtually inert gas), N20 (a potent greenhouse gas) ,. and NH3 (a nutrient). This large difference in enviromnemtal impacts would be of importance to the Bay Program. Even if such a subdivision of the NVE would be done just qualitatively for the different MTTs (e.g., only estimate what proportion is N2 (the least environmental impact loss)) such information would be much more useful in the Bay Model than the current combined NVE. (Jack Meisinger at April AgWG)	The panel made the decision not to further define transfer efficiencies to individual forms of the nutrients. We felt that there is not enough farm-scale data to justify creating N_2, NO_X, and NH_3 transfer efficiencies for all of the technologies.	Air
CBC	Dear Jason and David: Thank you for the opportunity to comment on the Expert Panel's report addressing Manure Treatment Technologies. With full respect to timeline and by way of this e-mail, we are also sharing our comments (attached) with the Source Sector Workgroup and strategic members of the Modeling Workgroup who interface with the Source Sector Workgroup. If there are others who should be receiving these comments, we trust that you will help us to share the attachment to them. Thank you for your hard work, Ann	[full comments copied below]	-
CBC	Thank you for you work to determine how best to credit manure treatment technology in the model. We appreciate this opportunity to offer input on the Expert Panel's draft report. The Chesapeake Bay Program Expert Panel has done an incredibly thorough job analyzing the most common manure treatments used in the watershed and has recommended three credit types: a default credit when only the manure type and technology type are known; a defined credit when manure type and pertinent operating conditions of the treatment	Thank you for the positive feedback and for the CBC's own work on manure-to-energy initiatives in the watershed.	-

	technology are known; and a data driven credit for when actual monitoring data for a technology is available. This approach makes sense. We take issue with only one part of the analysis which is the default crediting of thermochemical and composting systems with nitrogen reductions for volatization of nitrogen.		
CBC	The CBC has long experience with manure to energy systems, having organized a Manure-to-Energy Summit in 2011, and having served on the Farm Manure to Energy Initiative that field tested and monitored emissions of several farm scale thermochemical technologies. In our experience some thermochemical systems volatize nitrogen into N2 (nitrogen) gas, which we understand is not environmentally harmful and does not deposit itself back onto the earth. These types of systems should receive a credit for nitrogen reductions. Other thermochemical systems and all composting methods volatize manure nitrogen into NH3 (ammonia) or NOx (nitrogen oxide) emissions which are deposited back to the earth as pollutants that run into the Bay, or are deposited directly to water bodies. These types of systems should not be credited for producing nitrogen reductions. Awarding nitrogen reduction credits for simply changing the form of pollution from land based pollution into to air pollution should not be approved because it does not reflect a real overall nitrogen reduction. The report acknowledges this issue where it explains nutrient transformations of thermochemical systems on page 31 and notes that "the deposition fate of ammonia and NOx may be of interest to other technical groups and/or future iterations of the model." We strongly suggest that this issue be addressed in this iteration of the model, or the Bay Program crediting methodology may unintentionally incentivize technologies that create environmentally harmful nitrogen emissions. We suggest that before the crediting methodology proposed by this expert panel is approved, either this issue be sent to the modeling workgroup to develop a more refined methodology for only crediting manure treatment systems for the N2 that is produced, and not for their NH3 or NOx emissions. As an	The panel reviewed the literature, and based on best professional judgement, provided estimates of the effect of manure treatment technologies on farmstead manure nutrient flow. The panel provided estimates of three masses of nutrients exiting a manure treatment technology: 1) nutrients remaining in the main manure stream, 2) nutrients transferred to the atmosphere, and 3) nutrients transferred to a byproduct stream more likely to be used off farm. Mass of nutrients leaving the technology by either the atmospheric or the "more likely to be used off-farm' path divided by the mass of nutrient entering the technology was defined as the transfer efficiency. We did not make any judgement on the final pollution potential inherent in these efficiencies. By no means are we suggesting that use of manure on-farm should be reduced by transferring nutrients to the atmosphere. The report provides the likely flow paths nutrients take after treatment. Transformation of nutrients is covered in the Review *of Available Science* section of each technology chapter. Potential environmental hazards of each technology is also addressed. The members of the panel who worked on both composting and thermochemical processing sections have included information on the nature of nitrogen emissions in the Review *of Available Science* section of the respective chapters. The depth to which the chapters delve into this subject reflects the extent of farm-based data in the scientific literatures. These issues are raised in the *Future Research* needs chapter and can be refined as more farm-based data is available in the future.	Air

	alternative, The Bay Program could decline to grant a default efficiency for nitrogen volatization, but instead could offer the data driven transfer efficiency for those systems that are monitored or can otherwise demonstrate which portion of manure nitrogen is being converted to N2.	The values in Table ES.1 in the Executive Summary and Table A.2 in Appendix A will be revised to reflect a future decision from the Modeling Workgroup on how to simulate and account for the emissions and redeposition of reactive nitrogen from BMPs within the watershed, including but not limited to the BMPs recommended by this panel.	
CBC	In addition, although this issue is outside the scope of the work of this expert panel, we ask that the Modeling Workgroup address a related question: If manure treatment technology is used to treat a farm's manure, would the model assume that replacement fertilizer is always applied according to a Nutrient Management Plan? How will this be handled where Nutrient Management Plans are not required? Please do not hesitate to contact us if you need further information. Our subject matter expert on staff, Bevin Buchheister can be reached at bevinb@chesbay.us or 410-263-3420.	This is related to the issue of replacement nutrients that is one component related to trading, which is being proposed for inclusion and resolution through a "policy group," formed by the partnership through the process that will be considered by the Management Board on June 16.	Misc
VA DCR	A few comments and questions on the report. I did a word document with track changes. I notated page numbers for each comment to assist in finding the excerpts. Document as a whole shows a lot of hard work and energy was devoted to it by those involved. Thanks to you and the group. Bobby Long Nutrient Management Coordinator, Animal Waste P.O. Box 130 Phenix, VA 23959 434-547-8172 bobby.long@dcr.virginia.gov	We appreciate the specific suggested edits for clarification and will include them.	Edits
CBF	Hey Jeremey – Attached please find CBF's comments on the manure treatment expert panel draft report. If you have any questions, please let me know. Thanks! Hope you are well. Beth	[copied comments from CBF memo below]	-

	** Beth L. McGee, Ph.D. Senior Regional Water Quality Scientist Chesapeake Bay Foundation 6 Herndon Avenue Annapolis, MD 21403 ph: 410-268-8816		
CBF	First, our sincere thanks to the Expert Panel for their work on the draft document. The scientific foundation of the Chesapeake Bay Program rests largely on the willingness of technical experts to engage in the process and help inform our decision-making tools. We very much appreciate their time and expertise. The draft document was comprehensive in its inclusion and discussion of various manure treatment technologies. We do, however, have some questions about how the various recommended efficiencies would actually be incorporated into the Chesapeake Bay Watershed Model/Scenario Builder and also, specifically, with how nitrogen emissions to the atmosphere will be handled. We request that these details be addressed and included in the final version of the report. Show how the efficiencies will be incorporated into Scenario Builder. On page 14, it is stated there are three ways that manure treatment technologies could be incorporated into Chesapeake Bay Program modeling tools. For clarity, we recommend that Figure TT.3 be modified to explicitly include these various options. Furthermore, we also recommend that the default and defined efficiencies recommended for the various technologies also refer back to this figure and that the text indicate where in the process these efficiencies will be applied. As it stands, we believe the transfer efficiencies make sense (except as noted below for air emissions), but their application as best management practice (BMP) efficiencies is unclear. **Include recommendations for how the technologies will be tracked, reported, and verified.** As stated in the July 2014 version of the "Protocol for the Development, Review, and Approval of Loading and Effectiveness Estimates for Nutrient and Sediment Controls in the Chesapeake Bay	Figure B.2 (page 10) will be revised to better illustrate where the panel's recommended transfer efficiencies (NVE, NSE, PSE) fit within the context of the modeling tools. Figure TT.3 serves a more general purpose. We think the updated Figure B.2 will address your first comment. Section 12 describes how the recommended BMPs can be verified using the CBP partnership's approved Agriculture BMP Verification Guidance. The methods used to verify BMPs are a decision made by the states given their respective priorities, programs and needs. To clarify, the separation efficiencies (NSE and PSE) developed by the panel are not recommended as BMPs that would be reportable for annual progress runs. The total mass of nitrogen and phosphorus remains the same following separation; the nutrient benefits would be accounted for through the Manure Transport BMP, which is already a part of the partnership's BMP verification guidance.	Verification

	Watershed Model," the panel should also provide a description of how the practice will tracked, reported, and verified by the jurisdictions. This is particularly important given that some of the treatment technology efficiencies rely on the assumption that nutrients will be moved to a "flow path more likely to be used off-farm." For example, as noted on page 72, "Nutrients in both the effluent and sludge streams are utilized in land application; however the smaller volume and mass of the sludge stream allows it to be transported more economically...making sludge more likely to be utilized off-farm." The separation efficiencies should not be applied unless it can be demonstrated that the sludge is indeed being transported. Another example is the efficiencies for liquid-solid separators that are also dependent on the assumption of off-farm transport. Overall, the panel needs to describe the tracking and verification for all the treatment technologies to ensure the benefits are appropriately credited.		
CBF	**Nitrogen losses to the atmosphere need to be characterized and addressed.** We echo the comments made by the Chesapeake Bay Commission (CBC), who questioned the default crediting of thermochemical and composting systems with nitrogen reductions for volatilization of nitrogen. In this context, benefits should only accrue to technologies where the emissions are demonstrated to be nitrogen (N2) gas. Other forms of nitrogen released by these technologies, e.g., ammonia and NOx, can have impacts on water quality and should not be ignored. The CBC presents a couple of options for addressing this concern and we request that this question be resolved before crediting alternate treatment technologies. In addition, if the form of nitrogen that is volatilized is not nitrogen gas, there needs to be a discussion of how this form of nitrogen will be captured in the Chesapeake Bay Watershed Model.	The members of the panel who worked on both composting and thermochemical processing sections have included information on the nature of nitrogen emissions in the *Review of Available Science* section of the respective chapters. The depth to which the chapters delve into this subject reflects the extent of farm-based data in the scientific literatures. These issues are raised in the Future Research needs chapter and will undoubtedly be addressed as more farm-based data is available. The values in Table ES.1 in the Executive Summary and Table A.2 in Appendix A will be revised to reflect a future decision from the Modeling Workgroup on how to simulate and account for the emissions and redeposition of reactive nitrogen from BMPs within the watershed, including but not limited to the BMPs recommended by this panel.	Air
CBF	Specific comments: Table C1. Is there a typo on the third line of the table? The NVE and NSE don't add up to 100. Table AD.3. We do not see support for the efficiencies	The discrepancy in Table C.1. was a typo. The NVE value for in-vessel and rotating bin composters has been corrected to 90%.	Edits

	attributed to the covered lagoon. Please provide more information on the justification for this estimate. In addition, as noted above, for this practice to be credited the ultimate fate of the sludge needs to be tracked and reported.	Table A.3 is the default transfer efficiencies for anaerobic digestion processes. If the sludge storage age for a covered lagoon is not known, the default value for separation efficiencies is zero. Normally, sludge is allowed to accumulate undisturbed in the first cell of a covered lagoon system for periods lasting longer than 20 years. In most cases, when sludge is removed from the lagoon cell it is land applied off-farm due to its concentrated fertilizer value -- and the fact that most farms do not have adequate land to apply the accumulated phosphorus. If it is known that sludge is stored in a covered lagoon longer than 10 years, then the defined values are 30% NSE and 50% PSE. These reflect the fact that sludge may be transferred off-farm, and these transfer efficiencies are the percentage of manure nutrients stored with sludge. Also, it should be noted the PSE and NSE values are not recommended as BMPs for annual progress reporting at this time.	
VA DEQ	Page 3 and 4 indicate a list of MTT BMPs 1 to 19 with varying degrees of TN reductions and no TP reduction. And indicates these are currently available for reporting. However, the NEIEN Appendix A (NEIEN NPS BMP CBP Data Flow_P6AppendixA 15_4_031416.xlsx) does not list any of the MTT BMPs. Instead it lists 20 other BMPs applied to the same simulated loadings source including the 8 BMPs mapped to the AWMS scenario builder BMP. This list of MTT BMPs 1 to 19 are based on thermochemical and composting technologies and is silent on the anaerobic digestion and other technologies which do have TN and TP reductions listed within the report. This is confusing as the report indicates other technologies and efficiencies that are not included in the list of reportable MTTs. It looks as if the list of available MTT BMPs should be expanded to include all where a NVE, NSE, or a PSE has been determined and beyond just thermochemical and composting methods. Also on page 4 the paragraph at the bottom of the table seems to contradict the table in that the paragraph says MTTs do not remove nutrients from manure	The bottom of page 3 notes that the MTT BMPs are only recommended for the Phase 6 CBWM. The statement that "The following manure treatment practices may be reported to the National Environmental Information Exchange Network (NEIEN) for credit in a progress scenario or reported to the CBPI for credit in a planning scenario" will be true following approval of the report by the WQGIT. If clarifying text is needed then it can be added as a part of that statement. Technologies with only NSE and PSE values described in this report are not included in Table ES1 because NSE and PSE values do not represent a change in the amount of TN or TP that is available for field application or transport in the modeling tools. See Summary Memo for proposed edits to these paragraphs	Reporting & Modeling

	but the table list TN removal numbers? Either they do remove TN as the table indicates or they do not as the paragraph would seem to indicate.	on pages 3 and 4.	

VA DEQ	It is also not abundantly clear as to if the proposed MTT BMPs are to replace the existing 20 BMPs actually listed in the NEIEN documentation and eligible to report or in addition to the following NEIEN Appendix A listed BMPs:
	• SB short name BarnRunoffCont:
	    o Barnyard Runoff Control RI,
	    o Barnyard Runoff Control;
	• SB short name LoafLot: Loafing Lot Management System;
	• SB short name DairyPrecFeed: Feed Management;
	• SB short name LitAmend: Amendments for the Treatment of Agricultural Wastes;
	• SB short name Manure Transport: Manure Transport;
	• SB short name: MortlityComp:
	    o Animal Compost Structure RI,
	    o Animal Mortality Facility,
	    o Composter Facilities,
	    o Composting Facilities, Dead Bird Composting Facility;
	• SB short name AWMS:
	    o Animal Waste Management Systems,
	    o Dry Waste Storage Structure RI,
	    o Waste Control Facilities,
	    o Waste Storage Facility, Waste Storage Pond,
	    o Waste Storage Facility, Waste Treatment – by animal type i.e. Waste Treatment – Beef, and Waste Treatment Lagoon.
		The MTT panel's recommendations have no effect on the existing definitions and procedures used for these BMPs in Scenario Builder and NEIEN. The proposed MTT BMPS are unique and separate from the identified existing BMPs.	Reporting & modeling

VA DEQ	It seems as if some of the proposed technologies cross over into the existing list of BMPs and previously established reduction potentials. Please be clear as whether the proposed technologies are a replacement of the 20 listed BMPs or not. And if they are replacing one or more clearly describe those being replaced. For example Wet Chemical Treatments of manures seems very close to Amendments for the Treatment of Agricultural Wastes BMP.	The panel looked at the effect of the individual treatment practices as described in the report and made a conscious effort to separate the effect of the treatment from the effect of other parts of the wider manure handling and management system, such as storage, handling, etc.. Effects of other BMPs that apply to separate parts of the manure handling and management system, such as those identified by the commenter (Mortality Composters, Barnyard Runoff,	Reporting & modeling

		Feed Management, etc.) were not a part of the MTT panel's scope in order to explicitly avoid the type of overlap that concerns the commenter. Relating to AWMS specifically, there are some practices that can potentially be considered both storage and treatment (e.g., treatment lagoons, page 53; in-house composting, page 40). These were explicitly addressed in the report and the MTT panel felt that the ongoing AWMS panel can better address such practices. The current Treatment of Agricultural Wastes BMP (aka litter amendments) are a type of dry chemical treatment and this panel did not make recommendations on dry chemical treatment procedures.	
VA DEQ	The report reads like the historical BMPs (20 listed above) would be reported as level 1 MTT BMPs and default to MTT 1 or MTT 7 when insufficient information is available for reporting as in we only know some kind of AWMS was implemented but we do not know the animal type or amounts of manure treated/managed. Or is it that these BMPs are reported as they have always been and MTT BMPs are reported in addition? If so the NEIEN appendix needs to have the complete listing of MTT BMPs (including anaerobic digestion and other technologies) and required reporting elements included. This would include the currently listed BMPs as well. And the report should make this very clear.	The previously listed BMPs are wholly separate BMPs and are already reported by the jurisdictions. The MTT BMPs will be reported in addition to those identified by the commenter. The MTT BMPs will be added to the NEIEN appendix for Phase 6 following WQGIT approval of the panel's report. Go to Appendix A for information about specific reporting elements. Anaerobic digestion is not being proposed as a Default or Defined BMP by the panel and thus does not have suggested reporting elements for addition to the NEIEN appendix.	Reporting & modeling
VA DEQ	Page 117 bullet 2 indicating the reporting of sampling information annually with the progress run BMP data via NEIEN needs re-thinking as there currently in Virginia does not exist the mechanism to collect the data and report it in a way it could be provided to CBP. Additionally, the NEIEN schema is not currently configured to accept this kind of data. There should be a simpler and less cumbersome method of reporting such data if it is actually or becomes available than via NEIEN.	As a new suite of BMPs it is expected that the jurisdictions will need time to work out procedures for collecting and reporting data for all of the recommended BMPs, not just Level 3 (MTT 19). The second bullet on page 117 will be amended to read as follows: "Sampling or monitoring data should be reported to the appropriate state/federal agency at least twice per year, preferably on a quarterly basis. MTT19 will allow jurisdictions to report total nitrogen volatilized by a system in a progress year."	Tracking and reporting

		Refer to Appendix A for more information about reporting elements for MTT19. NEIEN can accommodate the reporting of monitored pound reductions.	
VA DEQ	Page 118 has 6 bulleted items. Currently VA might be able to do the first 3 but do not see a way to get the latter 3 items. End user when manure brokers are involved creates a significant impediment to following this item. Brokers collect and comingle wastes from multiple farm operations and then carry that mixture to land application sites. True cradle to grave is not possible in such a scenario. Analysis of manures is not currently included in CBP reporting metrics within VA. Considerable effort will be needed to facilitate such and VA does not see this data if collected as being NEIEN reportable. Prefer a more straight-forward or less complicated way to report manure analysis than NEIEN if the data is even available to report.	The bulleted list on page 118 was largely informed by permit requirements in Virginia that were summarized in Table DD.1 for the reader. The information provided by Betsy Bowles (pers comm, 4/28/15) suggests that systems associated with permitted AFO facilities would have the information described in Section 10. Virginia and other jurisdictions will have time to consider their options to collect that data for annual progress submissions. If that information is not collected then the jurisdiction may be able to report the relevant Level 1 or Level 2 BMP, depending on the type of system and available information. While the panel cannot comment on ways to improve tracking/reporting in the states, it is understood that NEIEN can accommodate reporting a commingled waste stream by using the animal groups "livestock" or "poultry."	Tracking and reporting
VA DEQ	It seems there is a mixing of the manure transport BMP with manure transported after treatment by one or more of these technologies. There should be a way to report manure transported when there is no idea as to additional treatments verses those that are transported after treatment via the technologies listed in the document.	If the type of treatment is unknown but the transport is known, then it can be reported using the existing Manure Transport BMP. It is up to the jurisdiction to determine if their data is adequate to separate manure transport into treated (reported as MTT1-18) and untreated streams (Manure Transport).	Tracking and reporting
VA DEQ	Did not see an appendix showing how this panel's recommendations comport with the BMP Protocol.	Appendix B is posted at http://www.chesapeakebay.net/calendar/event/23875/	Misc
VA DEQ	It would seem that the currently acceptable BMPs tied to existing Scenario Builder short names need to be explained in relation to the new proposed BMPs and if there is any interaction or if these are all separate BMP or if any are mutually exclusive of and or replacing each other.	The 19 BMPs recommended by the MTT panel are new BMPs for the Phase 6 CBWM and entirely separate from current BMPs already tracked and reported in Phase 5.3.2.	Tracking and reporting
VA DEQ	Section 4 Thermochemical Conversion Processes has a table listing NVE, NSE, and PSE values (100% for TP) but the table on page 4 indicates zero TP efficiency, same for section 5 composting technologies. Additional explanation that NVE, NSE, or PSE of 100 equates to zero reduction and seemingly	NSE and PSE values represent separation of nutrients but do not represent a removal of nutrients in terms of TN or TP that is available in the treated manure for field application or transport in the modeling tools. The equations to calculate the NVE, NSE and PSE for each	NVE/NSE/PSE

	one of 95 would equate to a 5% reduction if this reviewer understands how the math works. Section 6 lists on page 63 NSE and PSE values for a BMP but the table on page 4 does not include it as a one of the reportable BMPs. Similar to section 7 dealing with settling technologies as listed on pages 74 and 78 and for section 8 pages 95 and 96. The report is not clear on why these apparent BMPs where not included in the MTT list provided on page 4 and in one of the provided appendixes.	technology are explained in the report along with a simplified "black box" diagram to illustrate how those values correspond to the outputs of that technology category. Perceived discrepancies in the NSE and PSE values across categories may occur if the reader does not refer to the specific equations and diagram provided in each chapter, as the terms in the equations may differ to reflect the specific technology as explained and diagrammed in the report.	
VA DEQ	Overall have confusion on the NVE and NSE values and the calculation of total N reduced. It seems as if these are both possible mechanisms for the attenuation or loss of nitrogen. That a value of 100 means zero reduction and a value of 0.0 means a 100% reduction. But that is not how it seems to be implemented in the table on page 4. It seems for the Thermochemical MTT's seem to have a TN reduction based on 1 – NSE value and for the Composting MTTs it is just the NVE value listed as the TN reduction even if there is a NSE value less than 100 for the same practice. If there is a NVE value less than 100 and a NSE value less than 100 would the TN reduction be some combination of NVE and NSE values and not based on only one of these values? Some of the equations specify dry manure and others do not. Manure analysis are typically expressed on a dry weight basis so why would not all the equations be based on dry manure nutrient values?	All of the equations used to calculate transfer efficiencies in this report use mass of TN and TP not the mass of manure. The general form of the equations can be found on page 17 (TT.1, TT.2 and TT.3). The specific equations to calculate transfer efficiencies for each technology is given in each technology section. In the paragraph below Equations TT.1, TT.2, and TT.3 on page 17, it is explained that "nutrient mas is expressed as total nitrogen (TN) and total phosphorus (TP) throughout this report." NVE is the percentage of TN entering the device that exits in a gaseous form. NSE is the percentage of TN entering the device that exits in a form more likely to be used off-farm (For TCC technologies, this is the percentage of TN leaving in ash or char. For composting this is the percentage of TN leaving in compost and compost tea). The % TN removals listed in Table ES.1 are percentages of TN leaving the technologies in gaseous form. For Thermochemical processes the reductions are equivalent to the defined NVE values found in table TCC5 (page 32). For composting processes, reductions are equivalent to the defined NVE values found in Table C8 on page 47 if the C:N of the bulking agent is known, and the default values found in Table C1 on page 41 if the C:N ration of the bulking agent is unknown.	NVE/NSE/PSE
Aqua Terra	Attached are comments on the report from Ron and me. We limited the scope of our comments to questions regarding	[see below]	-

	volatilization efficiencies for N components and a question on NSE and PSE for compost and anaerobic digestion.		
Aqua Terra	We will not attempt to provide comment on the full report and all the technologies. Our focus will be on the approach to representing efficiencies with a particular focus on volatilization as a BMP earning a reduction efficiency. We do have some expertise on MTTs, particularly composting which will be used in the discussion. It is obvious the panel has put much work into assessing technologies for manure treatment at all levels of sophistication. The use of "Nitrogen Volatilization Efficiency" **(NVE)** and "N or P Separation Efficiency**" (NSE or PSE)** is unique and we think the separation efficiency concept makes it clear that separation does not constitute use so reduction credit is not given until a post separation use **is implemented.** Nuances of this approach for composting and anaerobic digestion will be discussed later. We do not understand how volatilization efficiency results in N reductions across the different technologies used and the different forms of N emitted by different technologies. If N2 gas is volatilized it remains inert in the atmosphere and could be counted as a conversion reducing N available for loss without atmospheric impacts. Both nitrous oxide (NOX) and ammonia (NH3) can cause air pollution impacts and also be redeposited. Nitrous oxide tends to be carried in the global atmosphere whereas ammonia can be deposited both locally and become of global atmospheric emissions. Research indicates that 25-50% of emitted ammonia may be deposited within a few kilometers of the point of emission and is, of course, immediately biologically active whereas more globally deposited nitrous oxide would be converted to nitrate before becoming biologically active. While we are certain the expert panel understands the discussion above, it is unclear why "NVE" is not related to emitted N species and for technologies emitting nitrous oxide or ammonia, how it can be considered an "efficiency" given	The panel's charge was to evaluate the effect of manure treatment technologies to remove nutrients from manure prior to field application or transport. Nitrogen emissions and deposition is a part of the Airshed model component of the overall modeling suite and was not within the MTT Panel's scope. There is very limited data that quantifies the portions of N emissions by species. NOx data is more often available than Ammonia data since NOx is regulated under the federal Clean Air Act. A recent report from the Farm Manure to Energy Initiative (M2E Initiative) attempted to look at the mass balance of TN for four thermochemical (gasification and combustion) systems in the Chesapeake Bay region. Their findings suggest that the vast majority of nitrogen is emitted as N2 versus reactive forms (NOx and Ammonia). Their data also suggests that thermochemical systems release much more NOx than they do Ammonia. Based on this limited available data the panel feels it is reasonable to assume for the Default and Defined categories that 90% of nitrogen emissions is in the form of N2 from a combustion system (MTT5-6); 96% for gasification (MTT3-4). Similar data was not published for pyrolysis systems, but given the operating temperature and lack of oxygen it would be expected that a pyrolysis system would release more of its nitrogen in the form of N2 than a gasification system. However, to be conservative the gasification N2 rate of 96% could be used. The remainder of emitted nitrogen (10% for combustion; 4% for gasification and pyrolysis) would be assumed to be in reactive forms as NOx or NH3. However, the NOx emissions would still need to meet applicable state or federal air quality regulations. These percentages only apply to emitted nitrogen and do not	Air

	effects on both water and air quality. It is suggested that species of N emissions be estimated for all technologies and that NOX and ammonia not be considered as part of NVE.	change the panel's analysis of the N that remains in the ash/char (Table TCC.4). It should be noted that these percentages are based on a very limited number of systems and are not representative of all combustion or gasification systems. The performance of each thermochemical system will vary from other systems because each system will have unique operational characteristics, e.g., the characteristics of the manure or litter fed to the system, the feed rate, the system itself, system maintenance, pre-treatment or other steps in the process, etc. The panel's recommended values represent their best attempt at a realistic estimate for that type of technology's performance considering the potential variability. Every system will be unique, but these generalized rates will serve for the CBP's purposes. The CBPO modeling team is working on methods to adjust reductions from relevant agricultural BMPs to account for the deposition of reactive nitrogen forms emitted through those BMPs. It is understood that the Modeling Workgroup will include a discussion of this and the Airshed Model at its August Quarterly meeting. Thus the partnership, not the panel, will determine what adjustments should be made in the modeling tools to account for deposition of reactive nitrogen from relevant BMPs, not just MTT practices. The values in Table ES.1 in the Executive Summary and Table A.2 in Appendix A will be revised to reflect a future decision from the Modeling Workgroup on how to simulate and account for the emissions and redeposition of reactive nitrogen from BMPs within the watershed, including but not limited to the BMPs recommended by this panel.	
Aqua Terra	This is particularly true for ammonia from composting. NVE for manures and bulking agents range from about one quarter to one third of the total nitrogen, except for closed vessel	The panel's charge was to evaluate the effect of manure treatment technologies to remove nutrients from manure prior to field application or transport. Nitrogen	Air (composting)

	systems, and essentially all of this is ammonia with local redeposition. The panel needs to provide the rationale for considering such emissions and efficiencies. Open compost facilities can become a "point source for atmospheric emissions and land/water deposition of ammonia if emission scrubbing (e.g. through finished compost) is not possible or not done.	emissions and deposition is a part of the Airshed model component of the overall modeling suite and was not within the MTT Panel's scope. There is very limited data that quantifies the portions of N emissions by species. NOx data is more often available than Ammonia data since NOx is regulated under the federal Clean Air Act. Scrubbing was not accounted for in NVE because this is a further treatment of emitted gas and does not affect the mass of TN remaining in compost after emission.	
Aqua Terra	Settling/storage devices or basins and solid separators (excluding centrifuges) may emit ammonia as well though likely at much lower levels than compost facilities (unless agitated). The panel needs to explain why these all have NVEs of 0 or provide estimated NVEs and explain what part of the emission/volatilization is ammonia, if possible. For all other systems, form of N in the NVE needs to be estimated, as suggested above, and N compounds potentially harmful to air and water should be removed from the "NVE". It would also seem appropriate to add a paragraph or section about N emissions and redeposition (particularly for ammonia) from MTTs and that activities like in-house "composting" of poultry litter are sources of nitrogen to water, not MTTs or BMPs.	There was not sufficient data to quantify an NVE for these systems at this time. There are built-in assumptions for volatilization loss during the storage/handling of manure and without more information the panel could not determine if the loss from settling or separation devices represented a net increase in the amount of volatilization that is assumed pre-field-application. There is a need for future research to provide more data about N emissions and losses from all types of manure treatment systems, including settling basins, mechanical separators, and composting facilities.	Air (STTL and MSLS)
Aqua Terra	The only comment beyond NVE and emissions from MTTs that we want to make regards N and P separation efficiencies for anaerobic digestors and composting. It is unclear why composting is given NSEs of 100% -NVE and PSEs of 100% while anaerobic digestors have NSEs and PSEs of 0%. In both cases, organic carbon is digested either anaerobically or aerobically and in composting a bulking agent is added to actually increase initial volume. The end products from both processes are a more stable, "user friendly" material that may	The confusion arises in the fact that PSE and NSE depend on nutrients being present in a stream that is likely to be used off-farm. Both digesters and composters provide a more stable form of nutrients to be used in land application. This has been acknowledged in the ancillary benefits section of both technology chapters. Composting Systems were given 100% PSE and NSE ranging from 75 to 90%; because all of the nutrients (with the exception of N transferred to	AD & composting

	lend itself to a wider range of both agricultural and other uses (anaerobic digestion residues may need more drying and both need to stabilize). As the panel developed the NVE, NSE, PSE approach, we think they possess the expertise and understanding to best address this apparent discrepancy. We suggest they either provide a technical explanation for the differences in NSE and PSE between composting and anaerobic digestion or modify NSE and PSE for anaerobic digestors to better reflect the improved potential for use following digestion consistent with compost. The concerns about using volatilization as an efficiency without regard to N species needs review throughout the report. The consistency of NVEs, NSEs and PSEs between and within technology groups needs further review by the panel for consistency. As stated above, we will not discuss technology specifics and operational functionality as we think the panel and others have more expertise to do that.	the atmosphere) have been converted to a form that is more likely to be used off-farm – compost. Digester effluent is not likely to be used off-farm because of its relatively large volume and relatively low nutrient concentration. These characteristics make digester effluent unlikely to be transported great distances; therefore, NSE and PSE are 0%. An exception is made for defined separation efficiencies for covered lagoon digesters, because the sludge from covered lagoons is removed every 10 to 20 years, and this sludge contains highly concentrated nutrients, making it more likely to be used off-farm. Also, most farms using covered lagoons do not have adequate acreage to accept the P load that has accumulated in lagoon sludge (in other words the CNMP of these farms handle effluent nutrients on an annual basis – sludge clean-out on a per incidental basis).	
PA DEP	We have done a detailed analysis of the attached Expert Panel report. We see that there was an extensive study done and it does: · Provide efficiencies for 18 manure treatment technologies for what occurs inside the "black box" , in the event there is minimal monitoring of the system. · Provide some good suggestions for what to ask the operators of manure technologies to report who use "Level 3 transfer efficiencies."	Thank you for your review and this positive feedback.	Misc
PA DEP	The "black box", I am referencing is what occurs when the manure enters one of these treatment technology facilities, how it is transformed within the facility, and how it exits the facility. This is a mass balance equation. We already have a high level of confidence in our current sampling and reporting protocol for this. Unfortunately, the report only focuses on half of the equation for nutrient reductions. The report falls short in providing what we need to move forward in a number of areas such as accounting for:	The identified areas are outside the scope of this panel. Air deposition of reactive nitrogen will be considered by the Modeling Workgroup at its August Quarterly meeting. This will affect other agricultural BMPs in addition to manure treatment technologies. The values in Table ES.1 in the Executive Summary and Table A.2 in Appendix A will be revised to reflect a future decision from the Modeling Workgroup on how to simulate and account for the emissions and	Various. Trading, Modeling, Air

	· Replacement nutrients · Crop uptake · Air deposition of NH4 · Ground water infiltration of nitrates · Other possible losses · Sediment and phosphorous runoff In other words, there is no methodology for accounting for what happens on the farm where the manure treated is removed. For example, is commercial fertilizer used instead? In addition, there is no methodology offered for consistently accounting for what happens to the byproducts from the treatment process. Some are re-sold as feed, some as fertilizer, some transported out of the watershed. The residual nutrients from these byproducts need to be considered. We need both what is inside the "black box" and what is outside to determine the amount of nutrient reductions generated. As part of the credit calculation application used to calculate credits for one such technology in Pennsylvania, we did create a very conservative model to attempt to accomplish this, but we were hoping to refine this model with the results from this panel report. Perhaps another look at this methodology would facilitate resolution of this issue.	redeposition of reactive nitrogen from BMPs within the watershed, including but not limited to the BMPs recommended by this panel. Replacement nutrients, crop application, storage or field runoff, crop uptake, groundwater or other losses are the purview of other CBP partnership groups as they relate to the Watershed Model and Scenario Builder, including the Agriculture Workgroup and its Ag Modeling Subcommittee and the Modeling Workgroup. For purposes of water quality trading and their associated tools, the jurisdictions can develop their own methods or assumptions regarding replacement nutrients and these other issues outside of the panel's scope. A "policy group" is proposed for the partnership to consider these issues as a possible add-on to the panel's technical recommendations for the effect of treatment.	
PA DEP	Finally, there are a number of policy issues that should not be addressed in this document. For example: · It is unclear what the purpose for Table DD1 is. · References as to how this panel report relates or can be applied to states Nutrient Trading Program on page 118 are problematic. We were hoping this report would provide a consistent methodology that could be used by all the states to calculate reductions from these technologies that could be transferred to nutrient credit calculation and facilitate Interstate Trading. This language is not helpful in achieving that goal.	Edits will be made to Section 10 to more clearly explain the intent of Table DD.1 for the reader. The paragraph on page 118 that mentions trading programs will be removed. The QAPP referenced in Section 10 is the QAPP(s) that each state provides to EPA related to the BMP data they submit every year in their annual progress runs. Under the BMP Verification Framework every jurisdiction documents their methods or procedures for verifying the BMP data. Nothing new is being	Various. Trading, modeling, verif.

	· Requiring monitoring protocols to be part of a state's QAPP is a policy decision that needs further discussion. Therefore, we would strongly recommend that any discussion after page 114 be deleted from the panel report to facilitate finalization. The policy issues and discussion on these last pages should be dealt with using the process now under development by the WQGIT, the Management Board and EPA in another forum. Thank you for the opportunity to comment on this important panel report. Should you wish to discuss this further, please do not hesitate to contact our PA members of the Agriculture Workgroup or myself. We look forward to working with you to finalize this report as quickly as possible. These technologies are a key component to Pennsylvania's continued progress towards achieving our reduction goals under the TMDL. Veronica Kasi |Program Manager Chesapeake Bay Program Office P. O. Box 8555 Department of Environmental Protection Rachel Carson State Office Building | Harrisburg PA 17105-8555 Phone: 717.772.4053 | Fax: 717.787-9549 www.dep.pa.gov	articulated in this regard, it is stating expectations that are already described in the BMP Verification Framework. We hope the edits to Section 10 will be sufficient (see Summary Memo for edits). Removing the entire discussion after page 114 would effectively remove the Level 3 (Data Driven) category and we understand it is not PA DEP's intention to remove that recommendation.	
MD	Hi Jeremy! Attached is the compilation of comments from MDE, MDA, and DNR. Best, Susan Susan Frick Payne Program Coordinator Ecosystem Markets Maryland Department of Agriculture 50 Harry S. Truman Parkway	[see comments below]	

	Annapolis, MD 21401 410-841-5897 susan.payne@maryland.gov		
MDE	1. The panel did not create pathways for the different forms of material that will potentially be transported vs. others that may remain on a farm (e.g. solids vs. liquids). As an example the "Compost Tea" could be used to fertilize fields on a farm while the remaining solids could be transported elsewhere. CBPO is aware of this concern.	The panel determined there was no change in total nutrients in the primary manure stream for field application or transport due to separation technologies. On a related note, the Manure Transport BMP will allow jurisdictions to report % moisture content as a part of that BMP in Phase 6, but that is not a component of this panel's recommendations.	Reporting & modeling
MDE	2. The mass balance is important to understand in terms of potential air contribution: are there significant impacts or loading of nitrogen (in various forms) that the panel has noted or about which the panel has concerns following the use of any of the technologies reviewed?	Each technology chapter has a section on "potential hazards" of that technology. The panel does note that air emissions of gases such as NOx and NH3 can occur for TCC technologies. The proportion of N that is emitted in these forms will vary according to the specific system. Furthermore the panel is aware that state or federal policies may determine what is acceptable in terms of air emissions from a TCC system. The values in Table ES.1 in the Executive Summary and Table A.2 in Appendix A will be revised to reflect a future decision from the Modeling Workgroup on how to simulate and account for the emissions and redeposition of reactive nitrogen from BMPs within the watershed, including but not limited to the BMPs recommended by this panel. In the case of composting there can be loss of N in the form of ammonia during the composting process. If the compost pile has anoxic areas partial denitrification may result in N being emitted as N20. These potential N20 losses can be avoided if relevant composting guidance is followed.	Air
MDE	3. Reductions from this practice come through volatilization of nitrogen in various species, some bound N2 and others hazardous NOx. We have issues with giving credit when the nitrogen is most likely still impacting local water quality to some degree through deposition. It is also difficult to determine the percentage of each particular N species that was volatilized.	There is very limited information on the percentage of N species that are emitted. Furthermore, each individual treatment system will be unique due to its specific sequence of technologies, operational factors and/or regulatory requirements. For example, some systems may install thermal oxidizers or other equipment that converts almost all emitted nitrogen	Air

		into N2.	
MDE	4. In terms of market solutions, once the processed material has been reduced in mass but remains in a more concentrated form with respect to phosphorus, is it a concern that a market solution must be readily available in order for the P to be considered removed from the system? In other words, if one of the combustion processes concentrates the P into a char, does the panel have any concern that there must be a business readily capable of selling and removing the product for the process to be effective?	This issue was discussed during the panel's deliberations but the panel has no role to play in this area related to markets or marketable products. A clear conclusion of the panel is that the technologies described in this report offer the potential to provide more concentrated or specialized fertilizer products that are easier to ship longer distances. This offers more opportunity for private entities to market and sell such products but the panel's role is to make technical recommendations for the CBP partnership modeling tools, not to provide opinions on conditions or trends of the market for treated manure products. The modeling team and Modeling Workgroup are attempting to quantify the impacts to water quality due to increased or decreased nitrogen losses to the air from agricultural BMPs. The values in Table ES.1 in the Executive Summary and Table A.2 in Appendix A will be revised to reflect a future decision from the Modeling Workgroup on how to simulate and account for the emissions and redeposition of reactive nitrogen from BMPs within the watershed, including but not limited to the BMPs recommended by this panel.	Misc
MDE	5. In general, this BMP will be difficult and time consuming to track. Currently the State does not have an obvious means to report this BMP. In addition, the modeling mechanics of tracking and reporting two separate waste streams, with different nutrient levels determined by technology, has not been defined.	If the type of treatment is unknown but the transport is known, then it can be reported using the existing Manure Transport BMP. It is up to the jurisdiction to determine if their data is adequate to separate manure transport into treated (reported as MTT1-18) and untreated streams (Manure Transport).	reporting
MDA	1. According to page 118 of the report, "*The estimated nitrogen reductions associated with a given manure treatment system reported under Level 3 and calculated in the Chesapeake Bay Program Partnership environmental modeling tools will not necessarily be equal to credits generated (in pounds of TN) for water quality trading purposes. Water quality trading programs, whether intrastate or interstate, may have different calculation steps, retirement ratios, additionality requirements, or other factors that are not considered for this*	The referenced statement on page 118 will be removed. The issues mentioned (replacement nutrients, groundwater, runoff, etc.) were never a part of this panel's charge. The partnership review of the panel's report is an excellent opportunity for the jurisdictions and other partners to hold conversations on these other issues and how they relate to the states' trading	Trading

		panel's purposes. This may be a source of confusion if attempts are made to compare the reductions credited for a treatment system in the CBP partnership modeling tools with any water quality trading credits associated with that same manure treatment system under a state's water quality trading program." Maryland and other Bay states are looking to the BMP panel to provide clear guidance for determining water quality benefits/reductions and associated credits for nutrient trading activities. The factors cited above by the Panel - retirement ratios and additionality requirements - are not related to the initial generation of a credit, but rather are programmatic elements. We need further clarity on what occurs outside the "black box" since it is only a part of total nutrient reductions. It would be useful to have a formula for dealing with factors such as replacement nutrients, air disposition of ammonium and methane, ground water infiltration of nitrates, and sediment and phosphorus runoff.	programs. A "policy group" has been proposed for formation by the partnership in order to address these issues in a more appropriate forum than the MTT panel; that process can help inform how the states approach these issues for their water quality trading purposes.	
MDA	2.	Page 114 of the report addresses some of the above but then basically tells the states they are on their own. Maryland, Pennsylvania, and Virginia are trying to present a united front and this is not helpful. Given the potential controversy this page will cause with the purveyors of MTT technologies, it would be better to delete it from the report.	We hope the edits to Section 10 (see Summary Memo) address this issue, but the section is intended to document some basic information for the reader and the general partnership regarding the Data Driven category. Deleting the page entirely would remove necessary context about the Data Driven category.	Misc
MDA	3.	The Panel does not include consideration of the necessary mineral fertilizer that would likely be required to meet a crop's agronomic need, should a MTT be utilized and create an organic product that could be transported off-farm.	Field application, nutrient spread, and crop need are outside the scope of this panel. Information provided in this report can be used to estimate reduced needs of mineral fertilizer and potential creation of organic products by technologies, however.	Misc. Field and other pathways
MDA	4.	MDA echoes the comments and concerns of MDE's comment #5 concerning the difficulty of tracking multiple waste streams, especially Settling MTTs and Solid-Liquid Separation MTTs. Much of this is operationally specific and would occur outside the Manure Transport cost-share program (e.g. ineligibility for short distances)	Those practices (settling, solid-liquid separation) are not being recommended for annual BMP reporting/tracking at this time. The only new effort under this panel's recommendations is that the jurisdictions will need to track and report the 19 new BMPs being proposed for Phase 6.	Reporting & modeling

	providing no records for reporting purposes. MDA recognizes that the Watershed Model considers a county-level mass balance such that short distance transporting would not effect a county's overall input load; however, the use of MTTs can alter the nutrient concentration of the multiple waste streams and we believe the Watershed Model should have a mechanism to reflect for those input changes.	The panel determined that the total nutrients remain unchanged by settling or separation MTTs. Changes to the Manure Transport BMP for Phase 6 that are currently being built into NEIEN may capture these effects going forward. It is understood that the Manure Transport practice may be tracked differently than a separator system would be.	
MD DNR	1. Default values still require manure type to be known. For technologies not taking advantage of NRCS or state funded cost-share or grant programs, how can MD track and report manure type? Some of the technologies require permits (air emissions, etc.) that could be used to track manure type, but not all do (i.e. compost).	If animal type is not known then standard modeling procedures will be applied, I.e. the reported tons will be distributed among applicable animal types for that geographic area.	Reporting & modeling
EnergyWorks	Jeremy, I'd like to add my congratulations to the MTT Expert Panel for its clear and thoughtful recommendations. I found the mass transfer framework very helpful in describing the combination of technologies used in our Gettysburg facility. We are proceeding with a credit generator certification renewal based on the panel's framework and terminology. Pat Patrick Thompson President & CEO EnergyWorks Group www.energyworks.com T 410-349-2001 x105 C 443-831-2360	Thank you for the positive feedback. Though it should be noted that the panel's recommendations are limited in their scope and only apply to the CBP Watershed Model and associated tools like Scenario Builder. There will be further discussion by the partnership and states to determine how to incorporate the panel's recommendations for other purposes, such as water quality trading.	Misc
Sustainable Chesapeake	Greetings Jeremy: Please accept the attached comments for the Manure Treatment Expert Panel's March 2016 draft report. I am really impressed by the work this panel was able to accomplish.	[See below]	-

	Please let me know if you have any questions, Kristen		
Sustainable Chesapeake	I am writing first to thank the Manure Treatment Technology Expert Panel for their outstanding work on the March 2016 Manure Treatment Technology report. Secondly, I am writing to provide comments regarding nitrogen reduction crediting for thermal manure-to-energy technologies. In the Chesapeake Bay Commissions' (CBC) May 2, 2016 memorandum to Dr. Doug Hamilton, staff express a concern that the default and defined transfer efficiencies award credits for volatilization of reactive nitrogen emissions (oxides of nitrogen and ammonia-nitrogen). We concur with CBC staff in this regard and recommend that that nitrogen reduction credits should not be issued for nitrogen volatilized in the reactive form. If the panel has already taken this into consideration, we suggest that the report provide clarification in this regard. Given that Table TCC.1. and TCC. 5 have nitrogen values less than 100 percent for combustion technologies, this may be the case. We would also like to direct the panel's attention to the final Farm Manure-to-Energy Initiative report, which includes a data on air emissions (Appendix E)and nutrient balance (Appendix G) for three thermal manure-to-energy technologies installed on farms in the Chesapeake Bay region (two combustion systems and a gasifier). Results from emissions testing indicate that the technologies vary in terms of reactive nitrogen reduction: http://articles.extension.org/pages/73602/farm-manure-to-energy-initiative-in-the-chesapeake-region-report-january-2016 Thank you for the opportunity to provide comments. Please do not hesitate to contact me via email at Kristen@susches.org; or by phone at 415-730-7503 with questions regarding the Farm Manure-to-Energy Initiative report.	The panel greatly appreciates the work of the Farm Manure-to-Energy (M2E) Initiative, in addition to your own work as Chair of the subgroup that worked to develop the charge for this panel. We appreciate the information provided by the M2E Initiative Report and the assistance provided to the panel on this issue. See our response to Aqua Terra for more details.	Air

EnviroKure	Hi Jeremy, So they decided not to review any novel approaches such as the EnviroKure aqueous composting process? Since we presented in December 2014 we have moved forward with building a plant in Harrington, DE that will utilize about 20% of the excess manure produced in DE annually when operating at full capacity, removing all but 0.3% of the P from that manure and shipping approximately 65% of all the nutrients out of the CBWS. Hope all is well, Sonia	The decision was made by the panel to not review aerobic treatment processes for liquid manure streams. Given the resources and time available, the panel decided to concentrate on the six technology categories based on potential for widespread use in the CBW and number of US based references containing data on technology performance. Aerobic treatment of liquid manure has been identified in further research needs as having potential to transform nutrients into a more transportable form. Although panels are prohibited from considering proprietary technologies, we encourage you to share data on the aqueous composting process in the refereed literature so that a future panel many include the information in their recommendations.	Misc-Composting
Coaltec	I am surprised that not once does the report mention that some of the technologies (such as MTT4 - high temperature gasification) are NRCS Conservation Practices.	If a state does track implementation of the interim NRCS Conservation Practice Code 735 (Waste Gasification Facility) then they will more likely have the information needed to report the system under the appropriate BMP (MTT3, MTT4, or possibly MTT19).	
Coaltec	Jeremy, Thank you again for all of your hard work on behalf of the Manure Treatment Technology BMP Panel over the past 18 months. The primary request we have is to add one sentence on page 3 to "Defined Transfer Efficiency (Level 2)." The sentence would read: "The Defined Transfer Efficiency (Level 2) should be used for large-scale technologies that process manure or waste from multiple farms within the same watershed, or that process the manure or waste from a single farm where the manure or waste is usually land applied on large acreage in the same or adjacent watersheds." As you know, each large-scale gasification system can process ~20,000 tons of poultry litter per year, or it dries and processes ~40,000 tons of 57%-moisture spent mushroom	The *protocol* leans heavily on the use of refereed journal articles as a foundation of scientific evidence on technology performance. NRCS standards also use the scientific literature in their development, so the same data is implied in the recommendations. It was the choice of the individual technology experts to use NRCS Conservation Practices as part of their best professional judgment in describing and quantifying technology performance. Some of the chapters do mention NRCS conservation practices. The anaerobic digestion chapter uses information on the ambient temperature lagoon standard in the literature review. However, this is in support of design standards for the technology. Scale of a particular technology is not a factor in determining the defined and data-driven recommendation. Defined recommendations are based	TCC

	substrate (SMS) per year. Currently, 20,000 tons of litter comes to us from dozens of poultry growers within a 15 to 20-mile radius, or 40,000 tons of spent mushroom substrate is owned by a single large mushroom farm (e.g. West Coast Mushrooms in Cecil County, MD). In either case, these large tonnages of litter and SMS are currently being land applied on thousands of acres in the Bay watershed. It would help enormously if the above sentence were added to page 3 of the Report, so nutrient trading officials in each Bay state understood that large-scale gasification systems have a well-known (i.e. Defined), on-site mass transfer efficiency and should not be subjected to the field-by-field, farm-by-farm calculations of the Nutrient Tracking Tool or the nutrient reduction (run-off) uncertainties of Model 6. We realize that the nitrogen that we drive off, and the phosphorus that we capture in the biochar will be subject to the tidal waters attenuation percentages in the Bay Model, but it is not reasonable or practical to require field-by-field and farm-by-farm calculations over thousands of acres in order to calculate gross (pre-attenuation) nutrient trading credits. As I indicated the other day, I think it would be very helpful if those who review and utilize the Panel's report understood that MTT4 ("Gasification – High Temperature") is NRCS Conservation Practice Code 735, entitled "Waste Gasification Facilities". I don't know where it is most appropriate to insert this, so I will leave this to your discretion. Please let me know your thoughts. Regards, Peter Thomas Coaltec Energy USA, Inc. 434-989-1417 (Cell) www.coaltecenergy.com	on pertinent process control factors explained in *Review of Available Science* section of each technology chapter. Data-driven recommendation are based on monitoring data of an individual unit, regardless of its size or input.	
Coaltec	Jeremy, Thanks for a good presentation this morning. I would like to suggest that the wording in the Data Driven Transfer Efficiency	 We have included a similar edit in combination with the other edits made to Section 10. See Summary Memo.	TCC

	category be slightly revised to read: "…. for a given farm or centralized manure treatment system is available." This wording helps by acknowledging that there are multi-farm technology systems like ours that fit into the Data Driven category. As an aside, we agree with the person who voiced a concern this morning about manure or litter incineration systems that simply convert nitrogen compounds in the manure to other forms that will harm the air or the Bay. She was also correct when pointing out that more costly systems convert the nitrogen compounds to N2 – the air we breathe. That is exactly why the EPA issued the attached letter ruling in December 2013, differentiating between biosolids incineration and oxygen-starved gasification systems that utilize an efficient thermal oxidizer.	The panel understands and agrees that some thermochemical systems can achieve extremely high quality air emissions by converting more of the nitrogen into inert N_2. That said, every system is unique and there will likely be reactive nitrogen emissions albeit in variable proportions.	
Coaltec	Jeremy, In the discussion of Data Collection and Reporting Protocols for Data Driven systems in Section 10 on page 114, a preface to the 3rd sentence in paragraph 1 could read: "Regardless of whether the data is generated by a single farm or by a multi-farm, centralized manure treatment facility, treatment systems reported under this category will have unique transfer efficiencies….." Peter	We are making a number of edits to Section 10 based on the combination of all comments received. See Summary Memo.	Edit
Coaltec	Jeremy, The Manure Expert Panel has created two gasification BMP categories, based solely on high temperature (> 1,500o F) versus low temperature (< 1,500o F). Highly automated, sensor-enabled, refractory-lined gasification / thermal oxidizer systems can and are operated at a wide range of temperatures, with infinite levels of oxygen, and with a wide variety of biomass residence times. Since manure gasification systems are covered by both interim NRCS Conservation Practice Code 735 ("Waste Gasification Facilities") and by permanent NRCS Conservation Practice Code 629 ("Waste Treatment"), and since the vast majority (>85%) of all of the nitrogen	The process factors section (page 28) will be modified to read: **Operating Temperature** plays a major large role in the removal of N from manure handling systems. Combustion systems typically operate at high temperatures (>1500 F) and with excess oxygen associated with the process, much of the nitrogen is converted to various gaseous forms. Gasification processes cover a wide range of temperatures. Generally as the operating temperature is reduced for gasification systems, the amount of nitrogen retained in the ash/char increases. Below 1,500° F, 75% of manure	TCC-gasification

	compounds in the manure or litter is converted to N2 over a wide range of temperatures and residence times, we ask that gasification be approved as a single Bay BMP, not two. Regards, Peter Thomas Coaltec Energy USA, Inc. 434-989-1417 (Cell) www.coaltecenergy.com	N is retained in char. Above 1,500° F, as much as 85% of manure N is lost in gaseous emissions. The 1,500 F temperature was chosen as a breakpoint for gasification processes. Even though nitrogen retention in ash/char does not have the drastic change at a given temperature, using 1,500 F provides a guide to use for systems without monitoring or testing data. This temperature could also vary depending on the system and operational performance.	
Coaltec	Jeremy and Doug, Based on the input during the initial reviews of the MTT report, it is clear that the issue of N emissions is going come up repeatedly during the reviews by the TOWG, the Agricultural Workgroup, Watershed Technical Workgroup and the Water Quality GIT. I hope you will insert language in the report to distinguish between the N emissions of gasification and composting, and not simply say that it was not in the scope of this Panel's responsibility. This language would be very helpful, so everyone will understand that gasification systems that include a thermal oxidizer drive off the N compounds in the manure or litter as N2 – the air we breathe – not as NOx. Manure composting has an unenviable N, methane and CO2 emissions profile, but it is what it is, and to my knowledge, there is not a technology can't solve this problem for composters. I can't speak to the other manure technologies that are discussed in the MTT report, but it is very important to note that gasifier / thermal oxidizer systems convert the N compounds in the manure or litter to N2. The very low emissions profile of gasification / thermal oxidizer systems (and its clear distinction from waste incinerators) is precisely why the EPA in Washington issued the attached letter ruling in December 2013. Regards, Peter Thomas Coaltec Energy USA, Inc. 434-989-1417 (Cell)	See Summary memo for proposed changes to page 31 on this issue. The Modeling Workgroup and the CBP partnership may wish to make adjustments to agriculture BMPs that are associated with atmospheric emissions and possible redeposition of reactive forms of nitrogen. These possible adjustments would be made to the Defined and Default categories for manure treatment BMPs (MTT1-6 for thermochemical), but such decisions are beyond the scope of this panel. The values in Table ES.1 in the Executive Summary and Table A.2 in Appendix A will be revised to reflect a future decision from the Modeling Workgroup on how to simulate and account for the emissions and redeposition of reactive nitrogen from BMPs within the watershed, including but not limited to the BMPs recommended by this panel.	Air

	www.coaltecenergy.com		
CleanBay	Hi Jeremy, Thank you for your work coordinating the BMP Assessment for the Chesapeake Bay Program. My name is Shawn Freitas and I am the CTO of CleanBay Renewables. We have recently reviewed the Report Recommendations from the BMP expert panel for Manure Treatment Technologies and have attached our initial comments. There are a number of concerns we hope to discuss with you and the panel and we will attend the webinar on Thurs 4/14 to learn more. CleanBay Renewables is a Maryland-based project development company founded to recycle agricultural and municipal wastes that are environmental "problems" and turn them into valuable renewable products. Maryland's Eastern Shore has significant quantities of excess poultry waste and an oversupply of phosphorus polluting the Chesapeake Bay, creating an opportunity to re-purpose this material. CleanBay aims to utilize poultry litter as the primary feedstock for a new class of anaerobic digestion biorefineries that will generate both electricity from biogas and inorganic chemicals such as struvite (a stable, time-release fertilizer), as well as a sustainable compost. Additional feedstocks and manures will also be incorporated in future designs to maximize the utilization of locally available resources and to improve the level of integration with the poultry industry. We are very interested in contributing to and supporting constructive nutrient management policies and regulations that will decrease eutrophication and improve the water quality of the Chesapeake Bay. As such, we have set up a series of meetings and discussions over the next few weeks with a wide range of manure technology and policy experts to discuss this report and to solicit additional feedback. We hope to incorporate this feedback into our final comments and if possible to work with the panel moving forward. Please feel free to contact me if you would like to discuss any of our initial comments, thanks.	[See below]	-

	Best Regards, Shawn Shawn Freitas Ph.D., MPM Chief Technology Officer Cleanbay Renewables 315-317-6056		
CleanBay	Hi Jeremy, I have attached the final version of the CleanBay comments on the report. We were concerned by a number of issues that we felt were not addressed in the public webinar on April 14th. As a result, we recently chose to directly reach out to additional members of the Chesapeake Bay Program to identify others with similar concerns and to establish a path forward. Our objective is to start constructive dialogue with members of the Agriculture Workgroup (AgWG), Watershed Technical Workgroup (WTWG), and the Water Quality Goal Implementation Team (WQGIT) regarding the issues we have outlined. We are still very interested in your feedback regarding these concerns and your guidance/direction as to how we can best make them part of the conversation moving forward. Thank you for your time, we look forward to hearing from you. Best Regards, Shawn Shawn Freitas Ph.D., MPM Chief Technology Officer Cleanbay Renewables 315-317-6056	[comments included below]	-
CleanBay	**Executive Summary** CleanBay Renewables is impressed and supportive of the development of the Chesapeake Bay Watershed Model (CBWM) and the use of Scenario Builder as powerful tools in the comprehensive management of nutrients loads in the region. As a project development company committed to	[Executive summary and summarized comments split only into two rows. Detailed comments given individual rows.]	Overall

	improving the condition of the Chesapeake Bay Watershed, CleanBay is focused entirely on implementing technologies with proven commercial track records of controlling nitrogen and phosphorous from poultry litter. As such, considerable diligence review has been completed on all of the technologies outlined in the Draft Manure Treatment Technologies report over the last few years. The objective of this report and in fact this environmental effort is to improve the water quality of the Chesapeake Bay. The fundamental issue with nitrogen and phosphorous in the watershed is not its phase (gas, liquid, or solid), but whether or not its release can be controlled such that eutrophication does not occur. Unfortunately, the report is based upon some incorrect assumptions. First, the report surmises that nitrogen loss through volatilization is a positive thing and the only way to control nitrogen. This is incorrect. In addition, this assumption is carried through the mass balance calculations causing further degradation of the report's conclusions. The finding that nitrogen volatilization is the preferred method for comparing functional to non-functional technologies will end up doing more harm than good if the base assumptions are not corrected. In the interest of supporting our common goals and completing a scientifically foundational report, we sincerely hope that the areas below will be systematically addressed. The Chesapeake Bay Program serves as a guiding body for a number of important issues and CleanBay would like the final report to better support local, federal, nonprofit, and industry leaders who have an interest or impact on the Chesapeake Bay watershed.	The panel did not make nor intended to imply that nitrogen volatilization is a positive way to control nitrogen. The panel did not attempt to provide recommendations on strategies to control or remove nutrients. The panel made recommendations on expected nutrient transfer and transformations based on data provided in the scientific literature. The panel's recommendations are consistent with the Phase 6 suite of partnership modeling tools. If nitrogen is not removed from the treated manure then under other procedures in the modeling tools that amount of nitrogen is still available for field application and transport. When volatilized from the treated manure, the amount of nitrogen in the applied or transported product has a lower total of nitrogen.	
CleanBay	Summarized concerns are as follows; - Nitrogen air pollution should be avoided at all costs and should not be considered a reasonable trade-off in order to address manure challenges. Sources of nitrogen air pollution need to be better characterized for all technologies studied by this report.	The panel did not recommend transferring manure nitrogen to the atmosphere as a means of reducing nitrogen loads on the farm. Nitrogen emissions are characterized to the extent possible given what is published in the scientific literature.	Overall

	- Manure drying, emissions scrubbing, and commercially practiced absorption/adsorption technologies are all fundamentally important processes for the reviewed manure conversions, but they have not been assessed or considered in the report. - Manure conversion technology mass balances in the report are frequently subjective and incomplete. Further work needs to be done for nutrient balances to adequately reflect actual working facilities. - Anaerobic digestion and composting are some of the most common and successful manure technologies in the world, but are negatively characterized by this report compared to thermal conversion technologies. Troubling scientific and engineering inaccuracies are used to justify these comparisons. - An improved assessment of nitrogen and phosphorous chemical speciation and phase (gas, liquid, solid) in manure inputs and manure conversion outputs is fundamentally necessary to support the nutrient management recommendations by this report General CleanBay recommendations are as follows; - Conventional mass balances centered on nitrogen and phosphorous should be used instead of mass transfer efficiency. Mass transfer efficiencies are used to check mass balance closures, but they are rarely used in chemical or environmental engineering as a method for comparison because theoretically all mass balances can come to closure.	Manure drying, adsorption/absorption processes are not widely practiced technologies. Emissions scrubbing was not within the charge of this panel. Total nutrient mass balances performed on an entire farm are rare in the scientific literature. Reports containing total mass balances were given the highest priority (provided validation was given by the authors) when it came to making recommendations based upon the state of science. The panel did not make any statement, nor intended to imply, that anaerobic digestion or composting are qualitatively better or worse than any other technology described in the report. The panel did not make nutrient management recommendations in the sense of nutrient use, loss, or recycling in the total farm system. The panel focused on the transference and transformation of nutrients by manure treatment technologies. Transfer of total nitrogen and phosphorus to the atmosphere and effluent streams is quantified in the transfer efficiencies tabulated in the report. Nutrient transformations are addressed in the text of the report in the review of science section of each technology chapter. It appears this is a misunderstanding based on the use of the word "efficiency" in describing how nutrients are transferred to different flow paths by technologies. Transfer efficiencies were calculated by first performing a mass balance on the technology. The mass leaving from a particular flow path was divided by influent mass to calculate the percentage of influent mass leaving by that flow path. Level 3 recommendations conceptually include all	

	- Nutrient management assessments for a given technology should encompass all of the primary and supporting processes that would be found at the facility site to support the manure conversion, avoiding potentially subjective definitions regarding importance. - The results and conclusions of the report will be far more defensible and manageable if the technology scope is initially narrowed to include only commercially practiced technologies. - CleanBay recommends that the basis for technology comparison be twofold with the primary objectives being; 1 - Production of more stable and controllable forms of nitrogen and phosphorous from manure that will not contribute to increased nutrient loads in surface waters. 2 - Significant volume reduction of the manure into liquids or solids that can be easily and economically transported out of the watershed	aspects of the given treatment system, but for the Default and Defined categories, it was not feasible to recommend distinct BMPs for every combination or permutation of treatment. An example of how individual treatment technologies may be combined was given on pages 19 through 21. The panel considered the categories that it was requested to review by the AgWG who had narrowed the scope based on recommendations of their subgroup for manure treatment technologies (appendix C). Through the panel deliberations the panel further narrowed its scope based on available published information and best professional judgment. Technologies were narrowed to those technologies that are currently used in the Chesapeake Bay Watershed or are likely to be used in the near future. This more or less describes the procedure the panel took. Production of various forms of nutrients (both stable and unstable) by the technologies is cataloged in the Review of Available Science section of each technology chapter. Release of unstable nutrients is listed in Potential Hazards subsection as appropriate. The panel did not break down forms of nutrients in determining transfer efficiencies because sufficient data is not available to do so for all the technologies.	
CleanBay	**Detailed Comments** 1. Nitrogen lost through volatilization primarily returns to the environment as precipitation. Decades of data and analysis by the National Atmospheric Deposition Program make this very clear and in fact, a Chesapeake Bay Program report from 1999, "The State of the Chesapeake Bay, CBP/TRS 222/108" clearly describes the significant effects of atmospheric deposition on the Bay. Nitrogen volatilizes primarily in two forms, either as nitrogen oxides (NOx) species or as ammonia. NOx is a potent	-	Air

		greenhouse gas and its emissions are regulated by the EPA. NOx also contributes to acid rain and widespread ecologic damage in the Northeast and Mid-Atlantic regions. Ammonia is a hazardous, flammable gas and is less regulated by the EPA, but associated with a variety of air quality issues. In most commercial and industrial practices, both of these nitrogen species are considered pollutants and are scrubbed from emissions using a variety of treatment processes. One of the commonalities in many of these treatment processes is that they are water-based. This is because both NOx and ammonia have high water solubility and this characteristic is also why these are the primary species associated with unwanted atmospheric nitrogen deposition through rain, snow, and fog.		
CleanBay	2.	Mass of Nitrogen Transferred to the Atmosphere expressed as Nitrogen Volatilization Efficiency (NVE) is a negative characteristic of a manure conversion process from an environmental perspective and should not be used as a constructive basis of comparison the way it is in this report. From an environmental perspective nitrogen emissions need to be addressed like they are in all other commercial/industrial processes where they are scrubbed using emissions treatment technologies. Furthermore, scrubbing represents an additional unit operation, increasing the cost and process intensity of any proposed project, and it does not actually get rid of the nitrogen species or even stabilize them. Scrubbing the nitrogen from these emissions simply puts it in a wastewater form where it will require yet another process so that it can either be bio-accumulated or precipitated as a mineral (similar to what happens in current municipal wastewater treatment). This report makes volatile nitrogen species a cornerstone of its proposed nitrogen management plan and does not ever address the multitude of scrubbing technologies and downstream processes that would be necessary to mitigate the effects of NOx and ammonia emissions. It is important that this is addressed for this report to have a meaningful and constructive impact on the CBWM and management of nutrients in the Chesapeake Bay watershed.	The MTT panel's role was to evaluate the effect of MTT technologies in terms of the nutrients that are subsequently transported or field applied; this approach is consistent with other agricultural BMPs that are associated with nitrogen losses through volatilization. The model has existing assumptions for volatilization that occurs through the manure storage/handling process and these assumptions were outside the scope of the MTT panel. The atmospheric deposition and air emissions are handled through a separate Airshed Model that is outside the scope of BMP panels. If adjustments to the panel's recommendations are necessary they will need to be informed by the Airshed Model and made based on information from the Modeling Workgroup and CBPO modeling team, not the expert panel. A recently released report by the Farm Manure-to-Energy Initiative (M2E) provides very useful information about relevant state and federal regulations that relate to some of the TCC technologies, i.e. gasification and combustion, with some preliminary discussion of a pyrolysis unit. While the M2E report only looks at systems for poultry operations this is information that the partnership should use because that report was specifically interested and charged to consider such	Air

		issues; the MTT panel and other expert panels are not asked to address policy issues beyond the basic information for reporting, tracking and verification called for in the BMP Protocol.	
CleanBay	3. In the report, Nitrogen Separation Efficiency (NSE) and Phosphorus Separation Efficiency (PSE) are logical values for achieving nutrient management objectives, but unfortunately they are calculated inappropriately in most of the mass balance assessments. In all techno-economic or lifecycle assessment, the location of the boundaries drawn on the process has major effects on the results of the model. This makes deciding where to draw the boundaries incredibly important as they can either make the model functional or undermine its predictive abilities. In the case of NSE and PSE, many of the boundaries have been drawn too closely to a single unit operation in a highly integrated process containing many unit operations, such that they suggest inaccurate and unreal NSE and PSE values.	This is appropriate given the panel's specific charge to only consider the effect of treatment. Other components of the system (storage/handling, transport, and field application) are the purview of other groups or panels.	NVE/NSE/PSE
CleanBay	4. The fate of nitrogen and phosphorous in combustion, gasification, and pyrolysis processes is very complicated and is not adequately assessed in this report. In efficient and commercially viable combustion and gasification processes where greater than 90% conversion of solids to gas occurs, over 95% of the nitrogen in the fuel will be volatilized as ammonia. In a gasifier, this ammonia will remain in the syngas unless it is removed and when the syngas is combusted the ammonia will be primarily converted to NOx. In a combustion process, most of this ammonia is rapidly converted to NOx. Depending on conditions a very small amount of ammonia may pyrolyze to N2, but the vast majority will remain either as ammonia or be converted to NOx when the ammonia is oxidized. The nitrogen emission challenges associated biomass gasification and combustion have been known for decades and unfortunately remain a weakness for this type of biomass conversion (Sethuraman, S. et al, Energy & Fuels,	The panel acknowledges that many of the technologies, especially pyrolysis, are in various stages of development at the national or international level. In the Chesapeake region the adoption and understanding is more in the early stages, especially for pyrolysis. The panel excluded torrefaction technologies because they are less tested than pyrolysis.	TCC

	2011; Jeremiáš, M., et al, Fuel, 2014; Van Huynh, C., Fuel, 2013). A slight exception is when gasification occurs with an excess of steam in which case most of the nitrogen will be converted to ammonia (NH3), but some will also be converted to hydrogen cyanide (HCN). In the case of combustion the NOx will be present in the CO2 emissions and must be scrubbed out. In the case of gasification the NOx, NH3, and HCN that is present in the syngas will either have to be scrubbed out upstream or downstream of the syngas combustion or synthesis processes. Nearly all of the nitrogen retained in the solid form in these processes is retained in the char, it is almost never found in the ash. The tables in the report suggest that low temperature gasification can retain a high level of nitrogen in the char. This is misleading because in reality inefficient gasification that does not effectively convert the solids to gases generates more char and less syngas. Because the nitrogen can be trapped in the char, inefficient gasification process will retain more nitrogen in the solid char form. This is a problem because commercially relevant gasifiers are designed to be efficient and even low temperature gasifiers running in the 1500-1400F temperature regime are optimized to generate as much gas as possible and therefore most of the nitrogen is converted to a gas form – where it presents a scrubbing challenge. The fast and slow pyrolysis values have the same weaknesses. Fast pyrolysis generates less char and more gas, slow pyrolysis generates more char and less gas, so the dynamic ends up being the same as gasification, processes that generate more char will leave more nitrogen trapped in a solid phase and vice versa for nitrogen in the gas phase. However, unlike gasification and combustion which are commercially proven processes for manure conversion, pyrolysis is not a commercially proven process yet and all of the data provided in this report is based on primary literature. This is a significant issue as this makes it more a literature review than a legitimate design basis for contributing to nutrient regulation for the state of Maryland. At this time there is no accurate way to assess the overall nitrogen mass		

	balance for a realistic manure pyrolysis facility.		
CleanBay	5. The statement that; "Gaseous emissions are considered true losses of nitrogen from the solid phase as ammonia emissions are generally less than 2% of total losses (Caron-Lassiter, 2014). Additionally, based on reported air permits (Energy Works Biopower, 2014) and available EPA air emission data NOx-N emissions can be estimated as 10% of feed N. The deposition fate of ammonia and NOx may be of interest to other technical groups and/or future iterations of the model." Represents a significant misinterpretation of those reports and their conclusions. This author must incorrectly assume that during combustion and gasification the nitrogen in the feedstock primarily converts back to dinitrogen gas (N2) as is found in the air, which is simply untrue. Combustion and gasification are thermal oxidation processes and they either pyrolyze organic nitrogen into ammonia or they oxidize the organic and inorganic nitrogen species into NOx. In lab settings, depending on the level of control of the combustion process, NOx emissions can be reduced and the level of ammonia pyrolysis back to N2 can be improved, but in commercial settings these results are rarely if ever achieved (Sethuraman, S. et al, Energy & Fuels, 2011; Jeremiáš, M., et al, Fuel, 2014; Van Huynh, C., Fuel, 2013).	Based on this limited available data the panel feels it is reasonable to assume for the Default and Defined categories that 90% of nitrogen emissions is in the form of N2 from a combustion system (MTT5-6); 96% for gasification (MTT3-4). Similar data was not published for pyrolysis systems, but given the operating temperature and lack of oxygen it would be expected that a pyrolysis system would release more of its nitrogen in the form of N2 than a gasification system. However, to be conservative the gasification N2 rate of 96% could be used. The remainder of emitted nitrogen (10% for combustion; 4% for gasification and pyrolysis) would be assumed to be in reactive forms as NOx or NH3. However, the NOx emissions would still need to meet applicable state or federal air quality regulations. These percentages only apply to emitted nitrogen and do not change the panel's analysis of the N that remains in the ash/char (Table TCC.4). It should be noted that these percentages are based on a very limited number of systems and are not representative of all combustion or gasification systems.	Air-TCC
CleanBay	6. Ignoring pyrolysis and focusing on commercially relevant combustion and gasification, the fate of phosphorous is also not nearly as simple as suggested. One of the primary issues is lightly described and that is the phosphorous present in the ash is highly soluble and capable of moving easily into a soil-water system. This means that even though the phosphorous can be up-concentrated through combustion and then shipped elsewhere, it is in an unstable form and likely to just cause eutrophication issues in a new place. CleanBay does not believe this is actually a solution to the problem, it is just outsourcing the problem. Alternatively, there have been some processes piloted in Europe (Outotec, Metawater, etc)	The management of nutrients on fields is a very important subject that is of tremendous interest by CBP partners, but this panel is not the group charged with making recommendations of how to estimate and simulate N and P fate and transport at the field scale.	TCC

	where phosphorous can be extracted from ash and stabilized into a more functional form. These are technologies worth reviewing and belong in this report if phosphorous management is considered important. When animals eat food they up-concentrate the phosphorous from the food in their manure and this has created a eutrophication problem. It defies logic that up-concentrating the phosphorous from manure into an even more phosphorous rich and unstable solid could be a solution to the eutrophication. The logical solution is to focus on putting the phosphorous into a stable and controllable form so that eutrophication is reduced.		
CleanBay	7. The comparative heating values provided for manure, grass, wood, and coal are inaccurate because the author either did not properly correct for moisture content before creating the comparison table or unfairly selected papers that studied highly irregular forms of the stated feedstocks. The heating value for the manure and the grass appear to have been calculated on a dry basis. The heating value for the wood and the coal are based on either wet feedstock or forms that are never commercially utilized. Dry wood has a heating value of ~8,500 BTU/lb and dry coal has a heating value of ~15,000 BTU/lb and this is well known (https://www.ecn.nl/phyllis2/). Based on ash content and carbon density alone, on a dry basis, it is thermodynamically impossible for manure to have a higher heating value than wood or coal. Furthermore, poultry litter tends to be the driest manure at around 20-30% moisture, but dairy, beef, and swine manure are incredibly wet at 60-70% moisture and make terrible combustion feedstocks without considerable drying. This is part of why farms tend to anaerobically digest this manure instead of combust it – if it was easy to burn they would be burning it because combustion is a common method of waste disposal on a farm. The energy value remaining in manure is largely related to the level of undigested carbohydrate, not the amount of dry and easily combustible carbon.	The values provided in Table TCC.6 came from the literature sources cited in the table caption. All are presented on a dry weight basis.	TCC

CleanBay	8. With regards to the earlier comment that the boundaries for assessing the NSE and PSE are unfair, thermochemical conversion offers two clear examples. The first is in regards to the scrubbing necessary to prevent the NH3 and NOx from being emitted to the atmosphere. The necessary scrubbing technologies would capture the NH3 and the NOx in an aqueous phase and this would then have to be treated, meaning technically thermochemical conversion should have a very low NVE. The other major technical omission is that of the dryers that would be necessary. In order to combust or gasify a feedstock with 60-70% moisture, it must be either dried or fired as a minority feedstock into a process being driven by a better fuel (natural gas, coal, wood, etc). If drying is not done and wet fuel is fired into the process, the oxidation and conversion will be inefficient and the emissions will be even worse. However, drying manure itself carries challenges because it is an energy intensive process and it is likely to cause significant NH3 emissions. Technically these NH3 emissions could increase the NVE, but it is more likely that they would represent such a significant air quality threat that these emissions would need to be scrubbed the same way the combustion/gasification emissions would need to be scrubbed. Not addressing the necessary drying and air emissions scrubbing technologies needed for thermochemical conversion invalidates any functional mass & energy balance calculations for these processes and demands a reassessment of the NSE and PSE.	On page 26 the panel points out that combustion, pyrolysis and gasification "are used to convert drier waste such as poultry and turkey litter. Wetter materials, such as slurry or semi-solid dairy and swine manure must undergo desiccating pretreatment (solid-liquid separation, composting, or air drying) before conversion by pyrolysis and gasification. Pretreatment processes may be energy intensive…"	TCC
CleanBay	9. The composting section is well written and properly assumes that nitrogen will be primarily transformed to solid microbial biomass and nitrates or emitted as gaseous NH3 or NOx. The remaining mobile nitrogen will be found solubilized in the liquid leachate, primarily in inorganic forms. However, there is very little discussion about the fact that level of nitrate/nitrite and NH3/NH4 can be higher in compost than it is in manure and that these nitrogen species are very water soluble. Addressing	These are excellent points for the partnership to consider regarding the runoff and leaching characteristics in the context of field application. It was not the MTT panel's role to recommend how these products could be different from regular manure or inorganic fertilizers in their runoff characteristics. Though outside the scope of this panel, it's important to note that each state in the watershed has its own regulations regarding agricultural nutrient management.	Composting

	the nitrogen solubility and runoff considerations around compost is very important for nutrient management. The same needs to be done for compost tea and leachates. Additionally, these mobile nitrogen species can be concentrated and stabilized through the addition of different minerals and also carbon char products like activated carbon, charcoal, and biochar. From a nutrient management perspective, reviewing methods for stabilizing the nitrogen forms expected from compost is as important as considering composting itself.	Each state makes its own determinations of how to work with farmers to set appropriate rates, timing, and type of nutrient inputs, and this would apply to manure, treated manure or inorganic fertilizers.	
CleanBay	10. Unfortunately, the composting section makes some of the same improper assumptions about phosphorous as the thermochemical section. Phosphorous from compost ends up being fairly mobile and while it does not leave in a gaseous form, it can absolutely be extracted by water. Compost tea and leachate tends to contain fairly high levels of phosphates and unfortunately, when used in excessive amounts, compost has increasingly been shown to contribute to eutrophication. From a mass balance perspective, composting results in a minor loss of carbon, and additional time for bacteria to heat and breakdown organic matter. This has a positive effect on reducing pathogens and bringing the compost closer to a soil-state, but it actually concentrates the phosphorous a little and liberates more free phosphate from the phytic acids that it is bound in. This makes the phosphorous in compost more mobile than the phosphorous in manure and while this increases plant uptake, it also means that high levels of rainfall can cause compost to be a contributor to eutrophication. Like the nitrogen species, these mobile phosphorous species can be concentrated and stabilized through the addition of different minerals and also carbon char products like activated carbon, charcoal, and biochar. From a nutrient management perspective, reviewing methods for stabilizing the phosphorous forms expected from compost is as important as considering composting itself.	The panel notes on page 48 that there is greater loss of ammonia if the composting process is not complete. If the pile contains anoxic areas there may also be losses in the form of $N_2 0$. The model already has assumptions that certain amounts of nitrogen from the manure will be lost in the form of NH3 between excretion and field application.	Composting
CleanBay	11. An important differentiator of composting compared to	The NVE values given in this report are the total mass	Composting

	thermochemical and anaerobic digestion conversion processes is that composting is an open reactor system and the other two are closed. This presents an emissions challenge that the report does not address. Unlike the NVE values from thermochemical and anaerobic digestion processes, which in practice would nearly always be zero due to scrubbing, the NVE values from composting are real because composting emissions cannot be easily controlled. The NH3 and NOx that is released from the compost during the composting process will drift into the air and then be returned to the watershed as precipitation. While the NVE values from composting are not very high, it is important to address them as an uncontrolled emission with negative effects on the environment.	of nitrogen exiting the system via gaseous forms. Scrubbing exhaust gases does not change NVE in the way it is used in this report. The panel was charged with determining the percentage of manure nitrogen transferred to the atmosphere and, therefore, not present in the manure stream after it passes through a technology. Biofiltration is commonly used to remove odors and, to some extent ammonia, from the exhaust of forced aeration composters. Adding a biofilter to treat exhaust gases will not change the mass of nitrogen remaining in compost, however.	
CleanBay	12. The weakest and most unfair assessment in this report is the Anaerobic Digestion section. The "Transfer Efficiencies of Anaerobic Digestion" and "Default Transfer Efficiencies for Anaerobic Digestion" paragraphs are incorrect and misleading. Anaerobic digestion is a significant manure conversion process similar in many respects to thermochemical conversion. Manure is broken down at a molecular level in a heated aqueous environment from a combination of bacterial, thermal, and hydrolytic mechanisms. This conversion results in 60-80% of the solid carbon being converted into gas composed primarily of methane (CH4) and carbon dioxide (CO2). This gas is known as biogas and the process of converting the carbon into a gas at this scale also logically has effects on the nitrogen and phosphorous. The nitrogen is heavily converted into NH3/NH3 species and also some nitrate/nitrite similar to compost. When NH4 is the dominant species the nitrogen tends to concentrate in the solid sludge material as various precipitates. When NH3 is the dominant species the nitrogen tends to concentrate in the biogas as gaseous ammonia. A similar conversion happens with the phosphates. The phosphates present in manure are frequently organphosphates with a minority or inorganic phosphate minerals. During the anaerobic	We cannot find any information in the report that contradicts this information. As for the unfairness of the assessment and the misleading nature of the anaerobic digestion chapter, perhaps more is being read into the information. It cannot be denied that anaerobic digestion does not alter the mass of total manure nitrogen and phosphorus passing through the reactor. There is no transfer to a more transportable form unless sludge is separated from effluent, which is effectively done in the management of covered lagoon digesters (and other high-rate systems that are not covered in this report). The panel has not come across data to support the assertion that significant loss of nitrogen occurs because of ammonia in biogas.	AD

	conversion process, particularly thermophilic conversions, the organophosphates (phytic acid, other phytates, etc) are broken down and the orthophosphate levels are increased. Depending on feedstock chemistry and anaerobic digester conditions, this orthophosphate is usually bound and mineralized by an ionic alkali and alkaline metal species that are also solubilized in the solution. This is a precipitation process that converts the phosphorous to a stable inorganic form, similar to the forms in which geologic rock phosphates are typically found. The phosphorous is never found in the biogas and is always up-concentrated in the sludge, similar to the concentrating that occurs in the ash and char with thermochemical conversions.		
CleanBay	13. From a mass balance perspective, the report suggests an impossible thermodynamic scenario regarding nitrogen and phosphorous and furthermore, the notion that 10 years is a necessary or legitimate retention time is unreasonable. Most commercial anaerobic digesters have retention times on the order of 20-30 days and in this time 60-80% of the solid feedstock mass is converted to the gaseous biogas form. This leaves 20-40% of the mass in the sludge form that must be removed, otherwise it would build up indefinitely and the conversion would have to stop. Therefore, sludge that has no more digestible carbon to contribute to the bacterial ecosystem in the reactor is removed regularly. It is also illogical to assume that manure and sludge are mixed in such a way that fresh manure is removed from the system when sludge is removed. This would be counterproductive to the objective of converting the digestible carbon remaining in the manure and to making biogas. All anaerobic digesters are operated so that the sludge removed is material that has experienced the longest possible retention time and therefore has experienced the greatest up-concentrating of inorganic components. This means the incoming manure and outgoing sludge are absolutely not the same material.	The ten years sludge storage for covered lagoon digesters has nothing to do with the hydraulic retention time of the digester. A covered lagoon is not a "commercial digester" as described. The statements made show a misunderstanding of the operation of covered lagoon digesters. Fresh manure and sludge are not mixed during application. Sludge is allowed to accumulate undisturbed in the first cell of the two cell covered lagoon system for periods lasting longer than 20 years. In most cases, when sludge is removed from the lagoon it is land applied off-farm due to its (as correctly stated) concentrated fertilizer value combined with the fact that most farms do not have adequate land to apply the phosphorus load that has accumulated for up to 20 years. The recommendation for 30% NSE and 50% PSE for covered lagoon digesters is based on the mass of nutrients contained in sludge when it is transferred off-farm. We see nothing in the chemical descriptions presented by CleanBay Renewable inconsistent with what is written in the report	AD

CleanBay	14. If the nitrogen and phosphorous were not removed regularly in the sludge and to a certain extent in the biogas, then they would just build up forever until the system no longer operated. This is clearly not a logical approach to mass flow for a reactor type that has enjoyed substantial success and commercial implementations globally. The mass and concentration of nitrogen and phosphorus in the sludge is always significantly higher than it is in the manure, usually by 3-5x depending on the efficiency of the anaerobic digester and the concentration of nitrogen and phosphorous in the feedstock. More importantly though are the forms of nitrogen and phosphorous found in the sludge. The phosphorous in the sludge is primarily found in an inorganic mineral form compared to the manure where it is predominately in an organic form. The nitrogen is primarily found as NH3/NH4 and nitrate/nitrite compared to the manure where it often found as urea and various types of organic nitrogen species. This conversion of the phosphorus and nitrogen species into these new forms is a major benefit from the stability and control perspective, offering important advantages for processes that aim to capture these elements in a functional form and prevent eutrophication. As a result, the NVE, NSE, and PSE values for anaerobic digestion are incorrect.	Sludge is stored in the first cell of covered lagoons. Sludge is the solid breakdown product of anaerobic digestion. Liquid and gaseous byproducts are removed from the cell on a daily basis. Sludge accumulates in the lagoon cell until it reaches a point at which the treatment process is hindered. At this point, sludge is removed. Based on NRCS and ASABE standards, 10 to 20 years sludge storage should be provided to ensure continuous operation. Covered lagoons are the most widely used anaerobic digestion system for flushed swine manure in the US. They are not as efficient (measured as biogas produced per reactor volume) as other digestion systems, and they do not produce biogas on a year-round basis in temperate climates. Never the less, there are a number of covered lagoon digesters treating dairy manure in the Chesapeake Bay Watershed. If large scale hog production were to move further north into the Virginia portion of the Bay Watershed, the covered lagoon digester will undoubtable be the most common anaerobic digestion system used. The transfer efficiencies contained in this report only take into account total nutrient masses, and should not be used to infer qualitative benefits of the treatment. Ancillary benefits of technologies are addressed in each chapter.	AD
CleanBay	15. A final significant aspect of anaerobic digesters that is not addressed in the report nitrogen mass balance is the ultimate fate of biogas which is always combusted either to generate heat or energy. Exactly like thermochemical conversion, any NH3 or NOx that is present in the biogas will either have to be scrubbed out upstream or downstream of the biogas combustion process. However, in the case of biogas because the NH3 and NOx concentrations are lower than those found in manure combustion processes, biogas can be scrubbed with much smaller and less intensive scrubbers that often trap the nitrogen species in stable solid phases through biofiltration and mineralization.	The panel did not find data to support the argument that a significant portion of manure nitrogen exits a digester in biogas. As a point of reference, biogas scrubbers rarely are used to remove nitrogenous gases from biogas. They are primarily used to remove H_2S and organic sulfides from biogas.	AD

CleanBay	16. The remaining sections on settling, mechanical solid-liquid separation, and wet chemical treatment are good, but organized improperly and suggest that these processes are used for manure conversion, which is untrue. The three currently practiced manure conversion technologies are only thermochemical, composting, and anaerobic digestion. These processes fundamentally alter the molecular and chemical makeup of the manure and generate outputs that are significantly different than the manure inputs. Settling, mechanical solid-liquid separation, and wet chemical treatment do not perform the same function and in fact are only used in practice to support thermochemical, composting, and anaerobic digestion conversion processes. Addressing these methods as separate processes from a mass balance perspective is confusing and creates an untenable situation from a nutrient management perspective, particularly given that all conversion processes in commercial practice are highly integrated and utilize many different supporting unit operations. This report should be organized to focus on the 3 primary conversion processes and then it should address all the supporting unit operations within those sections. This is the only way to develop a comprehensive and functional mass balance for comparing the conversion processes.	The panel was tasked to provide recommendation on a number of manure treatment processes. Wet chemical treatments and solid-liquid separation were among the technologies requested. Most treatment technologies used on-farm are not highly integrated systems utilizing many different supporting unit operation. The most common manure treatment system in the Chesapeake Bay Watershed is a stand-alone settling basin or mechanical separator. True, these do not fundamentally alter the chemical structure of manure nutrients, but their ability to separate farm manure flows into concentrated nutrient streams is important when considering the transport BMP used in modelling tools. Wet chemical treatments do alter the chemical make-up of nutrients. Precipitation of soluble phosphorus into struvite is as fundamentally different in its use as fertilizer as conversion of protein or urea nitrogen into ammoniacal forms by anaerobic digestion.	STTL, MSLS, WCT
CleanBay	17. Not covering adsorption and absorption as supporting processes in the wet chemical treatment section is inappropriate given the importance of these mechanisms for the solid outputs of the anaerobic digestion and composting conversion processes. On a mass basis the primary outputs of these two manure conversion	The wet chemical section only dealt with liquid manure. Dry chemical treatments were considered, but were not dealt with as major technology because their use in the watershed (primarily with dry poultry litter) does not alter the total nutrient loadings during land application, nor make the materials more transportable.	WCT

	technologies are solids and one of the principal ways to stabilize and improve solids is to blend in adsorptive and absorptive materials. These materials contribute to mineralization or ion exchange and they result in dramatically improved retention and controlled release of nutrients. The use of these materials is highly common in the management of storm-water and municipal wastewater treatment for these exact reasons. The fact that the wet chemical treatment section focuses almost entirely on treatment of liquid streams means that is assesses mass balance considerations that have minimal importance and impact on traditional manure conversion technologies. This is not to suggest that these precipitation methods could not be utilized on liquids in a greater extent for improving manure conversion nutrient management in the future, just that it is currently not practiced often.		
CleanBay	**Recommendations** The calculating and use of Level 3 Transfer Efficiencies as described in this report need to be re-thought and improved for this plan to have positive effects on nutrient management in the Chesapeake Bay watershed. CleanBay believes that the report generally offers helpful background and introduction material for the various technologies involved in manure conversion, but would like to recommend alternative methods for assessing the nitrogen and phosphorus pathways in support of improved nutrient management. Mass is neither created nor destroyed in any of these processes, so mass balances have a role, but mass transfer efficiency does not. Ultimately the nitrogen and phosphorous in the manure will enter the Box in the solid phase and will leave in some combination of solid, liquid, or gas phases. This means that there can never be any true difference between the mass of nutrient leaving the box and the mass of nutrients entering the box. Mass transfer efficiencies are used to check mass balance closures, but they are never used in chemical, process, or environmental engineering as a method for	This comment succinctly sums up the discussion of mass balances for manure treatment technologies contained in pages 17 and 18 of the report. Mass was not created nor destroyed in the process. Transfer efficiencies, as used in this report, simply convey the mass leaving any of the three possible paths leaving the box, by the mass entering the box. The panel fails to see how this approach is illogical.	Overall

	comparison because theoretically all mass balances come to closure because all mass can be accounted for. To suggest otherwise would be to suggest that mass is being destroyed or discounted and with the exception of fusion, fission, and transmutation processes this is impossible. Therefore, mass transfer efficiency as a standard of measure for this assessment needs to be replaced with something more logical. - CleanBay recommends that instead of mass transfer efficiency the Chesapeake Bay Watershed Model (CBWM) and Scenario Builder utilize conventional mass balances centered on nitrogen and phosphorous. These mass balances would be completed for each of the 3 major manure conversion processes using a minimum of 3 different combinations of the necessary supporting processes which include settling, mechanical solid-liquid separation, emissions scrubbing, drying, and wet chemical treatment. It would be understood and stated that more than 3 different combinations are possible, but these examples would provide a pragmatic platform for assessing commercially relevant, fully integrated, manure conversion processes. Conventional mass balances would track the nitrogen and phosphorus leaving the Box in all 3 phases (solid, liquid, gas). - CleanBay recommends that the boundaries on primary and supporting processes be drawn to encompass all of the processes that would be found at the facility site to support the manure conversion. Ultimately manure will arrive to the facility as an input and various outputs will leave. These outputs will include products and wastes and all outputs need to be accounted for to support responsible nutrient management. - CleanBay recommends that these mass balances only be completed for commercially practiced technologies. The reason being that mass balances	Traditional mass balances are used in this report. On pages 19-22, an example is given for using the mass balance approach on more than one technology in series. On pages 19-22, an example is given for using the mass balance approach on more than one technology in series. The decision hierarchy used by the panel (appendix C) placed the highest importance on data collected from farm-scale technologies. For some technologies, referred articles using on-farm data does not exist (see the section entitled concerns with relevant data on page 34 of the thermochemical conversion processes section). The need for data using appropriately scale units is a major recommendation in the future research needs section.	

	based on lab, bench, and pilot scale processes that are then scaled up to commercial scales using a multiplier, are frequently wrong. The results and conclusions of the report will be far more legitimate and realistic if the scope is initially narrowed to include only commercially practiced technologies. This will make data collection easier and more straightforward and will avoid the subjectivity that comes with interpretation and extrapolation from primary literature. The option to include new technologies in the future should be left open, but the fundamental platform for this initial report should be defined by functioning processes of the appropriate scale to provide a solid basis for comparison.	This is a first attempt to quantify the total nutrient transfers and transformations by manure treatment technologies. Future panels should take up where this one left off and more accurately define the chemical species emitted by the technologies.	
	• CleanBay recommends that the basis for comparison be twofold with the objectives being; 1 - Production of more stable and controllable forms of nitrogen and phosphorous from manure that will not contribute to increased nutrient loads in surface waters 2 - Significant volume reduction of the manure into liquids or solids that can be easily and economically transported out of the watershed	This was done -- PSE and NSE quantify the mass of nitrogen and phosphorus that can be more easily transported out of the watershed. Quantifying the nutrients themselves rather than total mass of manure fits more easily into the Bay modeling tools.	
	Both of these objectives have the potential to truly have an effect on the nitrogen and phosphorus cycles in the Chesapeake Bay watershed. Simply putting the nitrogen and phosphorous into a different phase or changing its concentration will not actually address the problem. However, improving its chemical stability and significantly reducing volume both contribute to better control over the fate of the nutrients and ultimately improving control is the core philosophy of any sound nutrient management plan. • CleanBay recommends that the production of stable	A good recommendation. The panel, however, was charged with determining the effect of manure treatment technologies with data and methods currently available in the scientific literature	

	and controllable forms of nitrogen and phosphorous be tested using a standardized method defined (or at least proposed) in the report. The most practical method would be a leach test to see what the effects of rainwater and soaking are on the nitrogen and phosphorous products. A grading scale can be used to determine the level of improvement over manure or vice versa if the product is less stable than manure. The scale should also contain values for commonly used agricultural fertilizers so that improvements over these products can be assessed as well. The level of improvement will be correlated with the CBWM and Scenario Builder to assess the effects on the watershed. - CleanBay recommends that volume reduction benefits only apply to outputs that will be removed from the watershed. Volume reduction is easily calculated for any commercially proven technology, but only solids or liquids that will be transported out of the watershed should be considered. Liquid and solids remaining in the watershed should not be counted towards any sort of benefit unless efforts have been made to stabilize as described above and the leach test has been performed. The benefits of volume reduction for transport need to be carefully considered alongside the sources of nitrogen fertilizers that will continue to be used by regional agricultural producers. While volume reduction provides a sort of control related to transportation, the benefits of this objective may be more related to improved ability to convert the outputs to a more stable form as described above. **Conclusions** A functional methodology for assessing manure conversion technologies is important to CleanBay and we would like to offer our support in improving the process. CleanBay is quite willing to provide process expertise on anaerobic digestion	Quantifying the nutrients themselves rather than total mass of manure fits more easily into the Bay modeling tools. Thank you for your support of a cleaner Chesapeake Bay.	

	and thermochemical conversions and to act as a sounding board for new ideas. As a company committed to improving the condition of the Chesapeake Bay Watershed and focused entirely on implementing technologies with proven commercial track records of controlling nitrogen and phosphorous from manure, CleanBay would like to participate in the development of improved nutrient management policies as much as possible. We look forward to attending the webinar and will be happy to set up additional meetings and calls to discuss further with any interested parties.		